MYCOTAXON

Volume 107, pp. 105–138 *January–March 2009*

The genus *Lepiota* (*Agaricales*, *Basidiomycota*) in Kerala State, India

T. K. Arun Kumar & P. Manimohan

tkakumar@gmail.com, pmanimohan@gmail.com
Department of Botany, University of Calicut
Kerala, 673 635, India

Abstract — Twenty-two taxa belonging to the agaric genus *Lepiota* are documented from Kerala State, India, including full descriptions and illustrations of eight new species and one new variety (*L. ananya*, *L. anupama*, *L. babruka*, *L. babruzalka*, *L. harithaka*, *L. nirupama*, *L. shveta*, *L. zalkavritha*, *L. brevipes* var. *distincta*). Of the eleven species that are new records for India, *Lepiota subincarnata*, *L. brevipes*, *L. elaiophylla*, *L. ianthinosquamosa* and *L. murinocapitata* are also reported for the first time from Asia. A key to the species of *Lepiota* in Kerala is given.

Key words — *Agaricaceae*, floristics, new taxa

Introduction

Formerly, agaricologists adopted a wide genus-concept of *Lepiota* (Pers.) Gray (*Agaricales*, *Basidiomycota*) that embraced all white-spored species of *Agaricaceae* with a scaly pileus, free lamellae, an annulus, and smooth dextrinoid spores. Enhanced understanding of the macro- and microcharacters, however, resulted in narrower generic concepts such as those held by Singer (1986) and Bon (1996). These new restricted genus-concepts pruned *Lepiota* sensu lato by removing taxa to smaller and segregate genera like *Cystolepiota* Singer, *Leucoagaricus* Locq. ex Singer, *Leucocoprinus* Pat., and *Macrolepiota* Singer based on more reliable differentiating characters. In this paper, we follow such a restricted concept of the genus.

Lepiota sensu stricto is relatively well known from the temperate regions of the world. However, lepiotas remain to be properly documented for most of the tropics. Manjula (1983) listed about 37 species (except for several synonyms and excluded species) of *Lepiota* sensu stricto recorded from India to which another 17 species have been subsequently added (Natarajan et al. 2005). Only three *Lepiota* species have been recorded so far from Kerala State, a geographical area that includes a major part of the Western Ghats of Peninsular India and which is recognized as one of the biodiversity hotspots of the world. These include

Lepiota guatopoensis Dennis (Vrinda et al. 2001), *Lepiota pyrrhaes* (Berk. & Broome) Sacc. (Vrinda et al. 1999), and *Lepiota viriditincta* (Manimohan et al. 1988). During our preliminary studies on the lepiotaceous fungi of Kerala, we encountered 22 *Lepiota* taxa including eight new species and one new variety. The new taxa are fully described and illustrated and others are documented below.

Materials and methods

Conventional morphology-based taxonomic methods were employed for this study. Microscopic observations were made on material mounted in 3% aqueous KOH. Melzer's reagent, cresyl blue and cotton blue were used to observe whether the spores were dextrinoid, metachromatic, and cyanophilic respectively. Colour codes refer to Kornerup & Wanscher (1978). Holotypes of all new taxa and additional and/or representative collections of all taxa documented here are deposited at Kew Herbarium and these collections are indicated by their Kew accession numbers. All other examined collections cited are in the personal herbarium of the second author.

Taxonomic account

Key to the *Lepiota* species of Kerala

1a. Spores not spurred 2
1b. Spores spurred 5

2a. Spores large, fusoid ..... ***L. metulispora***
2b. Spores small to medium-sized, not fusoid 3

3a. Pileus covering with pyramidal squamules, composed of chains of inflated, cylindrical or ellipsoid to globose terminal elements 7
3b. Pileus covering without pyramidal squamules, composed of ascending or erect clavate, cylindrical, fusoid, lageniform or ventricose terminal elements 4

4a. Clamp connections occasional to frequent 9
4b. Clamp connections absent 20

5a. Pileal covering with olive brown squamules; spores 6.5–9 × 3–4 µm ..... ***L. griseovirens***
5b. Pileal covering with brown or brownish orange squamules 6

6a. Spores 6–9.5 × 3–4 µm; elements of pileal covering without encrusting pigment ..... ***L. erythrosticta***
6b. Spores 9–12 × 3.5–4.5 µm; elements of pileal covering with encrusting pigment ..... ***L. castanea***

7a. Pileus light orange with brown squamules; lamellae light orange; context light orange; cheilocystidia and pleurocystidia absent; spores 4–6 × 2–3 µm ..... ***L. pseudoasperula***

7b. Pileus light brown, reddish brown or dark brown; lamellae white to yellowish white; context white to yellowish white; cheilocystidia present but pleurocystidia absent 8

8a. Cheilocystidia inflated-clavate, sphaeropedunculate or pedicellate-ovoid; clamp connections absent; spores 4.5–7 × 3–4 µm . . . . . ***L. babruka***

8b. Cheilocystidia clavate, utriform, cylindrical, pyriform, ellipsoid or ovoid; clamp connections present, but rare; spores 4–6 × 3 µm . . . . . ***L. nirupama***

9a. Pileal covering made of long fusoid, or flexuose elements 10

9b. Pileal covering not made of long fusoid, or flexuose elements but with clavate, cylindrical or ellipsoid elements 15

10a. Lamellae and context white to yellowish white; spore lengths range from 4.5 to 7.5µm 11

10b. Lamellae and context pastel-yellow; spore lengths range from 6 to 9 µm 14

11a. Pileal surface orange-white with cinnamon-brown squamules; elements of pileal covering up to 300 µm long; spores 4.5–7.5 × 3–5 µm . . . . . ***L. subincarnata***

11b. Pileal surface whitish or yellowish white with brown to reddish brown squamules; elements of pileal covering less than 200 µm long. 12

12a. Pileus 19–27 mm diameter; stipe turning brownish orange on bruising; cheilocystidia septate and occasionally with apical excrescences; spores 4.5–6 × 3–4.5 µm . . . . . ***L. zalkavritha***

12b. Pileus 4–17 mm diameter; stipe not exhibiting colour change on bruising; cheilocystidia aseptate;. 13

13a. Pileal background yellowish white, pale yellow/cream, without a rosy tinge; cheilocystidia thin-walled and without any encrustations; spores 4.5–7 × 2.5–4 µm . . . . . ***L. brevipes*** var. ***brevipes***

13b. Pileal background white, with a rosy tinge; cheilocystidia slightly thick- to thick-walled and with encrustations; spores 4–5 × 3 µm. . . ***L. brevipes*** var. ***distincta***

14a. Pileal covering made of long fusoid or clavate elements intermixed with a layer of smaller, invariably clavate elements; cheilocystidia cylindrical, clavate or utriform; spores 6–8 × 3–4.5 µm . . . . . ***L. xanthophylla***

14b. Pileal covering made up entirely of cylindrical or fusoid elements; cheilocystidia never utriform; spores 6–9 × 3–4.5 µm . . . . . ***L. elaiophylla***

15a. Basidiomata medium-sized; pileus more than 40 mm diameter; annulus with a dark grey squamulose rim; spores 6–9 × 3–4(–5) µm, lacrymoid to subcylindric, with a strong suprahilar depression; clamp connections abundant . . . . . ***L. ianthinosquamosa***

15b. Basidiomata small; pileus less than 25 mm diameter; annulus without a coloured rim; spores oblong, ellipsoid, subcylindrical or amygdaliform without any distinct suprahilar depression; clamp connections rare 16

16a. Basidiomata turn bluish green on bruising; spores 7–10 × 4–5 µm ***L. viriditincta***

16b. Basidiomata do not turn bluish green on bruising. 17

17a. Pileus striate; stipe covering a cutis of repent hyphae 18
17b. Pileus non-striate; stipe covering a disrupted cutis with ascending hyphal elements 19

18a. Pileus whitish with brownish grey to reddish grey squamules; lamellae white; spores 5–7 × 3.5–5 µm, oblong-ellipsoid to broadly ellipsoid; pileal elements without encrusting pigment..... ***L. anupama***
18b. Pileus whitish with dark brown squamules; lamellae yellowish; spores 5.5–8 × 3.5–4.5 µm, amygdaliform; pileal elements with encrusting pigment ..... ***L. ananya***

19a. Basidiomata dull white with reddish brown squamules; cheilocystidia versiform; pileal elements with encrusting pigment; spores 5.5–10.5 × 3.5–4.5 µm ..... ***L. babruzalka***
19b. Basidiomata entirely white; cheilocystidia clavate to cylindrico-clavate; pileal elements without encrusting pigment; spores 6–9.5 × 3.5–5 µm .... ***L. shveta***

20a. Basidiomata turning greyish green on bruising; terminal elements of pileal covering with encrusting pigment; spores 5–7 × 3–4 µm..... ***L. harithaka***
20b. Basidiomata not turning greyish green on bruising; terminal elements of pileal covering lacking encrusting pigment 21

21a. Pileus more than 15 mm diameter, white with brownish grey squamules; annulus fugacious; spores 5–8 × 3.5–5 µm, ellipsoid to oblong-ellipsoid ..... ***L. plumbicolor***
21b. Pileus less than 10 mm diameter, dark grey; annulus persistent; spores 4.5–6 × 3.5–4.5 µm, subamygdaliform ..... ***L. murinocapitata***

Lepiota metulispora (Berk. & Broome) Sacc., Syll. Fung. 5: 38 (1887)

Collections examined — **INDIA**, **Kerala State, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 28 June 2006, Arun Kumar *AK401* (*K(M)157144*); 7 July 2006, Arun Kumar *AK414*; 7 August 2006, Arun Kumar *AK414a*.

Discussion: Except for the presence of crowded cheilocystidia, the Kerala collections have characteristics that readily agree with the description of *L. metulispora* from Sri Lanka (Pegler 1972, 1986). This species has already been reported from India (Natarajan & Manjula 1983, Manjula 1983). *Lepiota magnispora* Murrill, is a very closely related species that mainly differs by having a yellowish or pinkish veil, a non-striate pileal margin, and a more fleshy and robust basidioma. In addition, the dark brown fibrillose scales on the pileus as well as the dark brown spiral bands towards the stipe base are differentiating features of that species.

Lepiota griseovirens Maire, Bull. trimes. Soc. mycol. France 44: 37 (1928)

Collections examined — **INDIA**, **Kerala State, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 9 August 2004, Arun Kumar *AK86* (*K(M)157135*); 10 August

2004, Arun Kumar *AK86a* (*K(M)157136*); 12 August 2004, Arun Kumar *AK86b*; 13 August 2004, Arun Kumar *AK86c*; 16 August 2004, Arun Kumar *AK86d*; 17 August 2004, Arun Kumar *AK90;* 15 October 2004, Arun Kumar *AK135;* 9 November 2004, Arun Kumar *AK178;* 30 June 2005, Arun Kumar *AK325;* 15 October 2006, Arun Kumar *AK458*.

Discussion: *Lepiota griseovirens* is characterized by a pileus with some shades of green, olive, or blue on a yellowish white background and dark grey to olive-brown squamules, especially at the centre. The Kerala collections are in close agreement with the descriptions of the species given by Candusso & Lanzoni (1990), Vellinga & Huijser (1993), Breitenbach & Kränzlin (1995), Bon (1996) and Vellinga (2001b), except for minor variations in basidial and cystidial dimensions. This is the first report of this species from India. A related species, *Lepiota grangei* (Eyre) Kühner resembles *L. griseovirens* in gross morphology as evident from a color photograph of that species from Switzerland (Breitenbach & Kränzlin, 1995), but could be separated based on its distinctly larger spores and mostly septate elements (normally with up to three clampless septa) of pileal covering with fine pigment encrustation. *Lepiota poliochloodes* Vellinga & Huijser, another greenish member of the genus, differs in having lighter pileal squamules, slightly smaller spores and clavate pileal end-cells. *Lepiota pilodes* Vellinga & Huijser differs mainly by its broad cheilocystidia and thin-layered pileal elements at the disc.

Lepiota erythrosticta (Berk. & Broome) Sacc., Syll. Fung. 5: 62 (1887)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 10 November 2003, Arun Kumar AK11 (K(M)157137); 5 October 2004, Arun Kumar AK119 (K(M)157138); 7 October 2004, Arun Kumar AK119a; 5 October 2004, Arun Kumar AK122; 9 November 2004, Arun Kumar AK175; 10 November 2004, Arun Kumar AK175a; 24 July 2006, Arun Kumar AK119b; 18 July 2006, Arun Kumar AK418; 27 September 2006, Arun Kumar AK449.

Discussion: This species has basidiomata covered with bright reddish brown squamules that give it a striking appearance. It is characterized by yellowish white lamellae; spores with an abaxial protraction; crowded, cylindric, clavate, or utriform cheilocystidia; and erect, cylindrico-clavate to subfusoid terminal elements with brown plasmatic pigment in the pileal covering.

The Kerala collections agree with the description of this species by Pegler (1972, 1986), but differ by the lack of a distinct lilaceous or vinaceous tint on the pileal surface. Dennis (1952) recorded smaller spores (5–6 × 3 μm) from the material from Trinidad. This is the first record of this species from India.

Lepiota castanea Quél., C.R. Ass. Franç. Av. Sci. 9: 661 (1881)

Collections examined — INDIA, Kerala State, Idukki District, MUNNAR: 9 June 2006, Arun Kumar AK392 (K(M)157123); 10 June 2006, Arun Kumar AK392a.

Discussion: The present collections agree well with the description of this species given by Vellinga (2001b) except that the septations of the pileal elements are not well developed. *Lepiota castanea* is a highly variable species displaying a wide range in macro and micromorphologic characters. This species is common in Europe, North America and in temperate Asia. Interestingly, collections of this species made from Kerala were from Munnar where cooler climatic conditions prevail owing to the high altitude. This is the first report of this species from India.

Lepiota pseudoasperula (Knudsen) Knudsen, Bot. Tidsskr. 75: 128 (1980)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 26 October 2004, Arun Kumar AK145 (K(M)157124); 1 November 2004, Arun Kumar AK145a; 2 November 2004, Arun Kumar AK162; 4 November 2004, Arun Kumar AK162a; 5 November 2004, Arun Kumar AK173; 10 November 2004, Arun Kumar AK145b.

Discussion: Knudsen originally described this species under the genus *Cystolepiota* but subsequently, he transferred it to *Lepiota* (Knudsen 1980). The slight variations noticed in the Kerala collections from the earlier descriptions (Knudsen 1978, 1980; Candusso & Lanzoni 1990, Vellinga 2001a) are the appendiculate pileal margin (margin recorded as 'even' in Knudsen 1978) and the slightly smaller dimensions of the pileal elements. Knudsen (1978, 1980) mentioned that the spore-print was never seen and Vellinga (2001a) assumed it to be probably white. During the present study, spore-print colour was found to be white. The Kerala collections represent the first record of this species from Asia.

Lepiota babruka T.K.A. Kumar & Manim., **sp. nov.** Figure 1

MycoBank MB511877

Pileus 30 mm latus, convexus, applanato expansus, umbonatus, brunneus, squamulis atrobrunneus obtectus. Lamellae liberae, albidae dein pallide luteae, confertae. Stipes 35 × 2 mm, brunneus dein atrobrunneus, fibrillosus. Sporae 4.5–7 × 3–4 µm, ovo-ellipsoideae vel oblongo-ellipsoideae, hyalinae, exiliter dextrinoideae. Basidia 10–17 × 6–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 13–34 × 10–20 µm, versiforma, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes fibulatae.

Holotype — INDIA, Kerala State, Kannur District, NEELIYARKOTTAM: 16 October 2004, Arun Kumar AK139 (K(M)155991 HOLOTYPE).

Etymology: *babruka* (Sanskrit), brownish

Basidioma somewhat medium-sized. Pileus 30 mm diam., broadly convex, becoming applanate, with a broad indistinct umbo; surface brown (6E6), with dark brown (6F8) squamules; squamules pyramidal at the disc, appressed and radiating towards the edge; margin incurved, becoming straight, eroded and

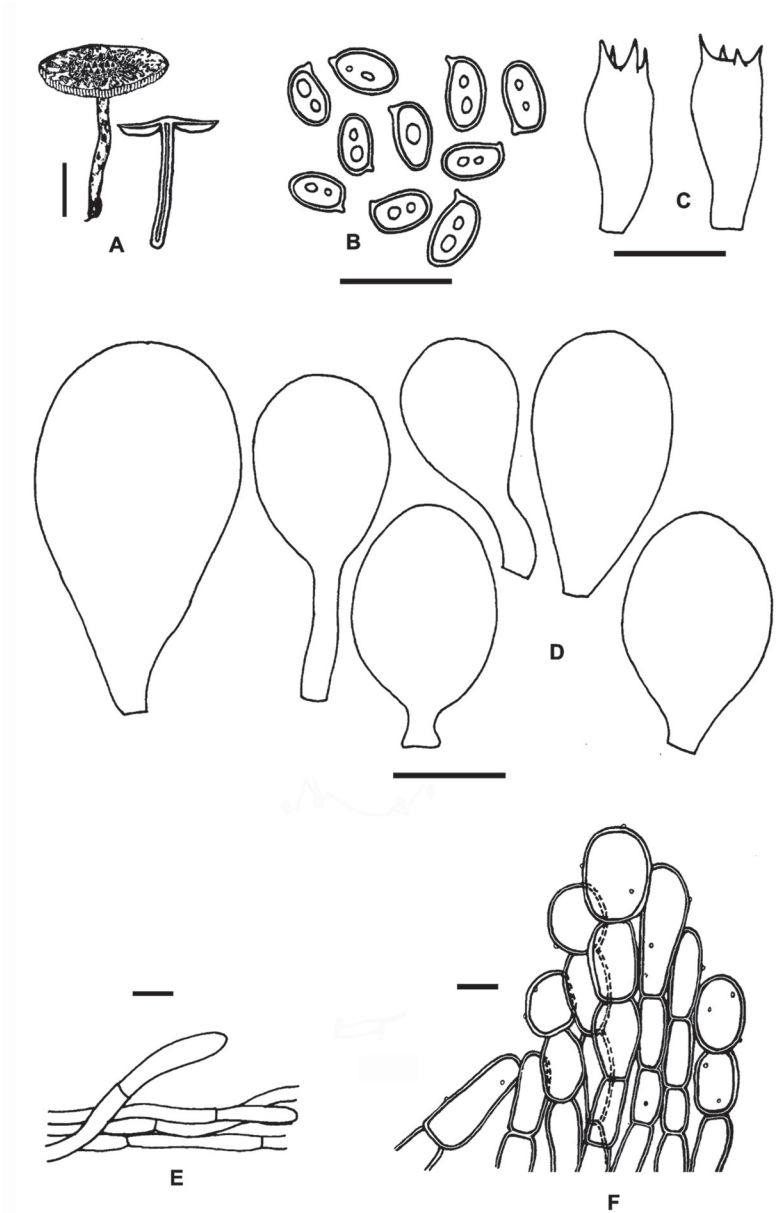


Figure 1. *Lepiota babruka*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

fissile with age. Lamellae free, initially white, turning yellowish white (4A2) to pale yellow (4A3), crowded, up to 5 mm wide, with lamellulae in 3–4 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 35 × 2 mm, central, terete, equal, fistulose; surface brown (6E6) becoming dark brown (6F8) with age, fibrillose; base arising from white mycelium. Annulus superior, fibrillose, evanescent, whitish. Context less than 2 mm thick, yellowish white (4A2). Odour not distinctive. Spore-print not obtained.

Spores 4.5–7 × 3–4 (6.2 ± 0.8 × 3.6 ± 0.4) µm, Q = 1.25–1.8, Qm = 1.6, ovo-ellipsoid to oblong-ellipsoid, hyaline, with refractive guttules, thick-walled, smooth, weakly dextrinoid, non-metachromatic, cyanophilic. Basidia 10–17 × 6–8 µm, cylindrico-clavate to clavate, hyaline, bearing 4 sterigmata up to 3 µm long. Lamella-edge sterile. Cheilocystidia crowded, 13–34 × 10–20 µm, inflated-clavate, sphaeropedunculate or pedicellate-ovoid, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–21 µm wide, inflated, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–10 µm wide, often inflated up to 20 µm wide, hyaline, thin-walled, septate, inamyloid. Pileal covering a disrupted cutis of filamentous hyphae, 3–15 µm wide, with transitions to trichodermial patches of erect hyphal bundles terminated by chains of short end cells; almost entirely trichodermial at the centre with agglutinated conical bundles reaching up to 500 µm in length; terminal cells 12–47 × 6–18 µm, cylindrical, ellipsoid, subglobose or clavate, thin- to slightly thick-walled with brown to dark brown plasmatic and membrane pigments. Stipe covering a cutis of repent, 2–10 µm wide, hyaline to pale yellowish brown hyphae with a few ascending terminal elements; terminal elements 20–32 × 5–9 µm, cylindrical, thin-walled, hyaline to pale yellow. All hyphae devoid of clamp connections.

Habitat: On soil among decaying leaf litter, solitary.

Discussion: This species is characterized by pyramidal squamules on the pileus, ovo-ellipsoid to oblong-ellipsoid spores, vesicular cheilocystidia, agglutinated chains of versiform end-cells in the pileal covering, and hyphae devoid of clamp connections.

The present collection resembles species of *Lepiota* section *Echinatae* Fayod although affinities with the genus *Cystolepiota* in the nature of pileal covering and in the weakly dextrinoid spores are evident. According to Vellinga (2001a) a velar structure with 'thin hyphae gradually transient into globose to ellipsoid elements, agglutinated to form pyramidal squamules' is characteristic of *Lepiota* section *Echinatae*. Following this observation, the present species is better placed in the genus *Lepiota*. However, this species remains distinct by virtue of its fibrillose fugacious annulus, weakly dextrinoid spores and clampless hyphae and does not match with any of the previously described species under

Lepiota or *Cystolepiota*. *Lepiota efibulis* Knudsen is a related species in *Lepiota* section *Echinatae* that also lacks clamp connections (Knudsen 1980, Vellinga 2001b), but that species differs from the present collection in having a distinct membranous annulus and much smaller spores that are metachromatic in cresyl blue.

Lepiota nirupama T.K.A. Kumar & Manim., **sp. nov.** FIGURE 2

MycoBank MB511878

Pileus 20–30 mm latus, primo subglobosus, postea convexus, pallide brunneus, rubro-brunneus vel atrobrunneus, squamulis verrusis ad discum confertioribus obtectus, obscure fibrillosus, non striatus. Lamellae liberae, albae, confertae. Stipes 32–40 × 2–5 mm, pallide brunneus vel rubro-brunneus, squamulis superficialis obtectus. Sporae 4–6 × 3 µm, ellipsoideae, hyalinae, dextrinoideae. Basidia 15–20 × 6–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 12–25 × 5–7 µm, clavata vel utriformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae raro fibulatae.

HOLOTYPE: INDIA, Kerala State, Thiruvananthapuram District, PALODE: 15 July 2005, Arun Kumar AK352 (K(M)155992 HOLOTYPE).

ETYMOLOGY: *nirupama* (Sanskrit), unequalled

BASIDIOMATA small. PILEUS 20–30 mm diam., initially subglobose, gradually parabolic or conico-convex and finally convex; surface light brown (7D5) to reddish brown (8E6) or dark brown (7F8), with abundant warty to conical, concolorous, detersile squamules, which upon detachment leaves a darker reticulate pattern on a lighter pileal background, more concentrated towards the disc and sparser towards the margin, finely fibrillose, non-striate; pellis peeling off as a layer from the margin on maturity exposing the context; margin initially incurved, later straight, eroded. LAMELLAE free, white, moderately crowded to crowded, up to 7 mm wide, with lamellulae in 4–5 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 32–40 × 2–5 mm, central, terete, almost equal, fistulose, becoming hollow with age; surface light brown (7F8) to reddish brown (8E6), with scattered pyramidal superficial squamules, whitish above the annulus and when young, minutely fibrillose; base arising from white mycelium. ANNULUS superior, membranous-fibrillose, ascending, movable, whitish, densely covered with whitish to light brown (7D5) floccose squamules on the lower side. CONTEXT up to 6 mm thick, white. ODOUR not distinctive. SPORE-PRINT not obtained.

SPORES 4–6 × 3 (5 ± 0.44 × 3 ± 0) µm, Q = 1.3–2, Qm = 1.6, ellipsoid, some with a slight hunch, hyaline, with refractive guttules, thin- to slightly thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 15–20 × 6–8 µm, cylindrico-clavate to clavate, with guttulate contents, hyaline, bearing 4 sterigmata up to 2 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 12–25 × 5–7 µm, clavate or utriform with a pedicel, thin-walled,

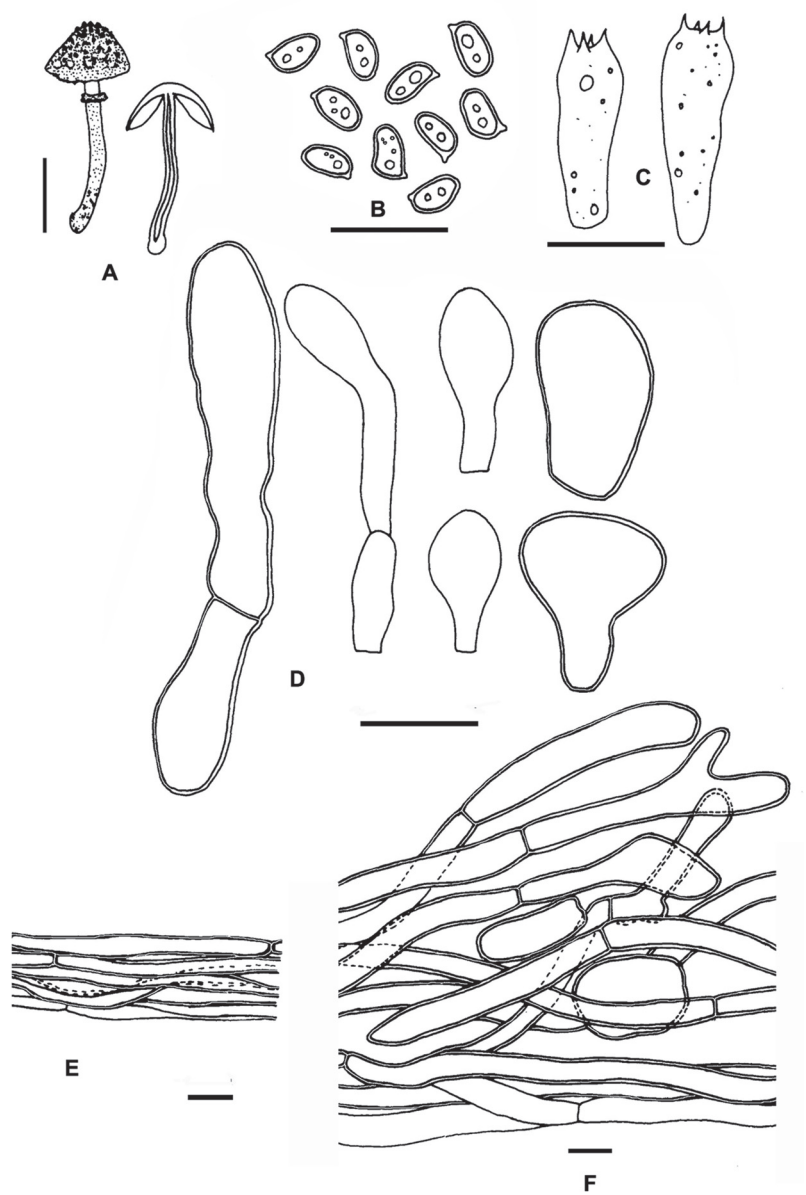


Figure 2. *Lepiota nirupama*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

hyaline, interspersed by relatively few, inflated, loosely attached, slightly thick-walled (up to 0.5 µm), hyaline, cylindrical, clavate, pyriform, utriform, ellipsoid or ovoid cells, 10–34 × 7–20 µm. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–12 µm wide, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–15 µm wide, cylindrical, hyaline to pale yellow, thin-walled, inamyloid. Pileal covering a highly disrupted cutis of 2–17 µm wide hyphae with trichodermial patches of ascending or erect, loosely attached, branched and thick-walled (up to 1 µm) hyphal elements with brown to dark brownish plasmatic and membrane pigments; terminal elements 17–70 × 4–17 µm, cylindrical, ellipsoid, oblong or ovoid. Stipe covering a cutis of repent, filamentous, 2–13 µm wide, thin- to slightly thick-walled (up to 1 µm) hyphae with hyaline to pale grey plasmatic pigments, disrupted to form occasional trichodermial transitions at the scales with loosely attached, erect or ascending cylindrical, clavate or ovoid elements that are slightly thick-walled and with pale yellow to brownish plasmatic and wall pigments. clamp connections rarely observed.

Habitat: On soil and decaying leaf litter, solitary or scattered in groups.

Additional collections examined — INDIA, Kerala State, Thiruvananthapuram District, PALODE: 18 July 2005, Arun Kumar AK353 (K(M)157131); 20 July 2005, Arun Kumar AK366.

Discussion: *Lepiota nirupama* is a distinct species of the section *Echinatae,* characterized by ellipsoid and dextrinoid spores; crowded cheilocystidia interspersed with inflated and slightly thick-walled versiform cells; and a pileal covering with loosely attached cylindrical, ellipsoid, oblong or ovoid terminal elements. It has distinctive reddish brown to dark brown pyramidal superficial squamules and a prominent ascending annulus densely covered with whitish to light brown floccose squamules. Combination of characteristics of the present material does not match any published descriptions.

Lepiota subincarnata J.E. Lange, Fl. Agaric. Danic. 5(Append.): V (1940)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 29 August 2003, Arun Kumar AK2 (K(M)157125); 11 November 2003, Arun Kumar AK2a (K(M)157126); 23 July 2004, Arun Kumar AK78; 25 July 2004, Arun Kumar AK78a; 4 October 2004, Arun Kumar AK118; 5 October 2004, Arun Kumar AK118a; 5 October 2004, Arun Kumar AK 120; 6 October 2004, Arun Kumar AK118b; 7 October 2004, Arun Kumar AK118c; 26 October 2004, Arun Kumar AK151; 29 September 2006, Arun Kumar AK452.

Discussion: The material of this species from Kerala is in close agreement with the description of the species by Pegler (1977) and Vellinga (2001b). The present collections slightly differ from the earlier descriptions in having a basal layer of pileal elements made up of cylindrical to ventricose elements along with the fusiform elements. This species is distinguished by cinnamon-brown squamules

on a paler pileal background, oblong-ellipsoid spores, clavate cheilocystidia, and a pileal covering made up of mostly subfusiform elements up to 400 µm long. This combination of characteristics places this species under the section *Ovisporae* (J.E. Lange) Kühner. This report represents the first record of this species from India.

Lepiota zalkavritha T.K.A. Kumar & Manim., **sp. nov.** FIGURE 3

MycoBank MB511879

Pileus 19–27 mm latus, subglobosus vel convexus applanato expansus, umbonatus, albidus, squamulis brunneis granularis obtectus. Lamellae liberae, primo albidae, postea pallide luteae, confertae. Stipes 25–34 × 4–5 mm, ad basim bulbosus, albidus, vulneratae brunneo-aurantius, squamulis brunneis obtectus. Sporae 4.5–6 × 3–4.5 µm, ellipsoideae hyalinae, crassitunicatae, dextrinoideae. Basidia 20–25 × 6–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 12–32 × 5.5–10 µm, versiformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis. Epicutis pilei e vallo trichodermiate efformata, ex hyphis erectis composita. Hyphae omnes fibulatae.

HOLOTYPE: INDIA, Kerala State, Calicut District, PUTHIYANGADI: 24 September 2006, Arun Kumar AK442 (K(M)155999, HOLOTYPE).

ETYMOLOGY: *zalkavritha* (Sanskrit), covered with scales

BASIDIOMATA small but robust. PILEUS 19–27 mm diam., subglobose when young, becoming convex to broadly convex, finally applanate, slightly umbonate at the disc when young but umbo often becomes indistinct with maturity; surface entirely covered with light brown (6D4, 6D5) to brown (6E5), granular to appressed fibrillose squamules on a dull white background, areolate cracking towards the margin, pruinose to smooth at the disc; pileal covering peels off as a layer from the margin exposing the white context; margin initially incurved, later straight, appendiculate. LAMELLAE free, initially whitish, turning yellowish white (4A2) with age, moderately crowded, up to 4 mm wide, with lamellulae in 3–5 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 25–34 × 4–5 mm, central, terete, almost equal, with a subbulbous to bulbous base, fistulose becoming hollow with age; surface whitish to orange-white (5A2) or light brown (6D4) turning brownish orange (7C3) on bruising, with discrete, fibrillose, dark brown (6E8) squamules forming broken girdles towards the lower portion; base arising from white mycelial cords. ANNULUS as a distinct zone of dark brown (6E8) persistent fibrillose squamules, occupying an inferior to central position on the stipe. CONTEXT up to 2 mm thick, whitish. ODOUR not distinctive. SPORE-PRINT white.

SPORES 4.5–6 × 3–4.5 (5.28 ± 0.82 × 3.8 ± 0.36) µm, Q = 1.2–1.7, Qm = 1.39, ovo-ellipsoid to ellipsoid, hyaline, with an oil guttule, smooth, thick-walled (up to 1 µm), dextrinoid, non-metachromatic, cyanophilic. BASIDIA 20–25 × 6–8 µm, clavate, with guttulate contents, bearing 4 sterigmata up to 4 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 12–32 × 5.5–10 µm,

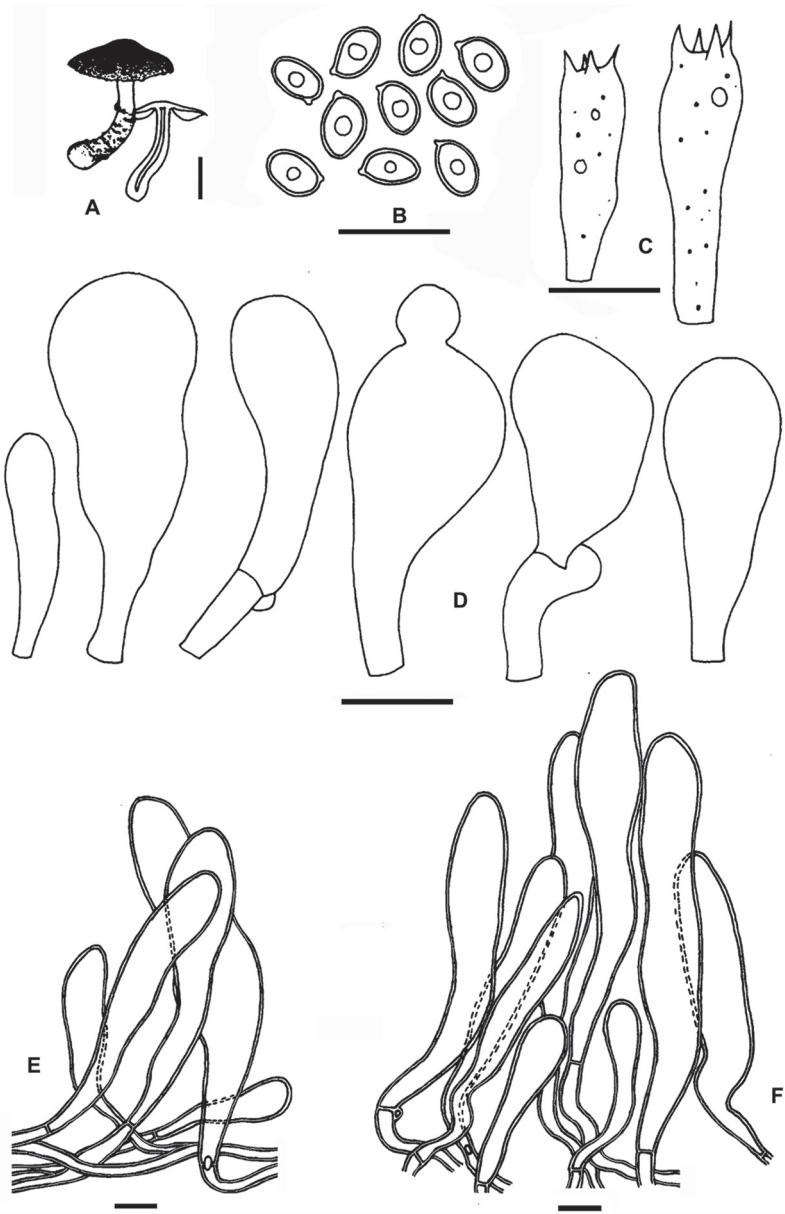


Figure 3. *Lepiota zalkavritha*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

narrowly clavate, clavate, broadly clavate, obpyriform, some with a subcapitate or rarely elongated apex (up to 30 µm long), at times septate, slightly inflated, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–10 µm wide, hyaline, thin-walled, septate, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–16 µm wide, inflated, hyaline to pale yellowish, thin- to slightly thick-walled, inamyloid. Pileal covering a trichodermium with erect or ascending terminal elements, 36–120 × 7–23 µm, mostly subfusoid or cylindric with obtuse tips, younger elements invariably clavate, thick-walled (up to 1 µm), with brownish to dark brownish plasmatic and membrane pigments. Stipe covering a cutis with occasional trichodermial patches of ascending or erect, cylindric, fusoid or clavate terminal elements 40–125 × 7–23 µm, thick-walled (up to 1 µm), with brownish to dark brown plasmatic and membrane pigments. All hyphae with clamp connections.

Habitat: On soil, solitary.

Additional collections examined — INDIA, Kerala State, Calicut District, PUTHIYANGADI: 9 October 2006, Arun Kumar AK453 (K(M)157134); 11 November 2006, Arun Kumar AK442a; 27 November 2006, Arun Kumar AK442b.

Discussion: This species clearly belongs in the section *Ovisporae* because of the ovoid spores and trichodermial nature of the pileal covering, but stands out from all the species described in that section owing to its unique combination of characters. The small spores, versiform cheilocystidia with occasional apical outgrowths, and the rather short (36–120 µm long), clavate, fusoid or cylindric pileal elements with brown to dark brown plasmatic and membrane pigments are diagnostic of this species. *Lepiota helveola* Bres., a species with a world-wide distribution (Guzmán & Guzmán-Dávalos 1992), seems to be a related species with almost similar cheilocystidial shapes and dimensions. Also, the elements of pileal covering in both species show a close morphological resemblance. However, *L. helveola* has larger basidiomata (Bon 1996: 57) and possess conspicuously larger spores (Huijsman 1962, Migliozzi 1997). A distant similarity with *L. azalearum* (Murrill) Dennis (Dennis 1952, 1970; Pegler 1983) could be attributed but that species clearly differs by its reddish brown pileus, evanescent annulus, spores that are less broad (2.5–3 µm), and fusiform pileal elements with pointed apex.

Lepiota brevipes Murrill, Quart. J. Florida Acad. Sci. 8(2): 178 (1945)

Collections examined — INDIA, Kerala State, Calicut District, PUTHIYANGADI: 27 October 2003, Arun Kumar AK7 (K(M)157127); 8 May 2004, Arun Kumar AK22; 12 May 2004, Arun Kumar AK22a; 13 May 2004, Arun Kumar AK22b; 16 May 2004, Arun Kumar AK22c; 18 May 2004, Arun Kumar AK22d; 10 October 2004, Arun Kumar AK130; KOYILANDI, 27 October 2004, Arun Kumar AK156; 3 November 2004, Arun Kumar AK167; PERUVANNAMUZHI, 13 November 2004, Arun Kumar AK193.

Discussion: This species has a yellowish white to cream-coloured pileus with brown to reddish brown appressed squamules, whitish to yellowish white lamellae, stipe covered with brownish squamules in broken girdles, small oblong-ellipsoid to cylindric spores, and a trichodermial pileal covering with ascending or erect cylindric to flexuouse terminal elements. Owing to the oblong-ellipsoid to subcylindric spores and the trichodermial nature of pileal covering, this species belong in section *Ovisporae*. The present collections have characters almost identical with the description of the holotype material of *L. brevipes* given by Smith (1965). They also agree with the description of that species based on the type and additional materials of the species from Florida by Akers & Sundberg (1998). The Kerala specimens however, had smaller basidiomata. This species was previously known only from Florida.

Lepiota brevipes* var. *distincta T.K.A. Kumar & Manim., **var. nov.** Figure 4

MycoBank MB511884

A typo differt: basidiomata roseotincta.

Holotype: INDIA, Kerala State, Thiruvananthapuram District, PALODE: 15 July 2005, Arun Kumar AK354 (K(M)157114, holotype).

Etymology: *distincta* (Latin), distinct

Basidiomata small. Pileus 11–16 mm diam., subglobose when young, becoming convex to broadly convex, finally applanate, with a broad umbo; surface whitish with reddish brown (8D6), appressed to recurved fibrillose squamules in broken, concentric circles that are concentrated towards the centre, pruinose at the disc, with an overall rosy tinge; margin initially incurved, later straight, appendiculate. Lamellae free, white, crowded, up to 2 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 25–70 × 2–3 mm, central, terete, almost equal, with a subbulbous base, fistulose; surface whitish to brownish orange (7C5), usually more whitish approaching the apex, with reddish brown (8D6), scattered fibrillose scales that are less towards the upper portion and concentrated towards the base; base arising from white mycelial cords. Annulus as a disrupted fibrillose zone, reddish brown. Context less than 1 mm thick, whitish. Odour not distinctive. Spore-print not obtained.

Spores 4–5 × 3 (4.8 ± 0.31 × 3 ± 0) µm, Q = 1.3–1.7, Qm = 1.6, ovo-ellipsoid to ellipsoid or subcylindric, hyaline, with oil guttules, smooth, thin- to slightly thick-walled, dextrinoid, non-metachromatic, cyanophilic. Basidia 14–18 × 6–7 µm, cylindrico-clavate to clavate, with guttulate contents, bearing 4 sterigmata up to 4 µm long. Lamella-edge sterile. Cheilocystidia 12–32 × 5.5–10 µm, cylindrical, clavate, broadly clavate, utriform, some with median constriction, hyaline to pale yellow, slightly thick- to thick-walled (up to 1 µm), with amorphous exudates on the surface. Pleurocystidia absent.

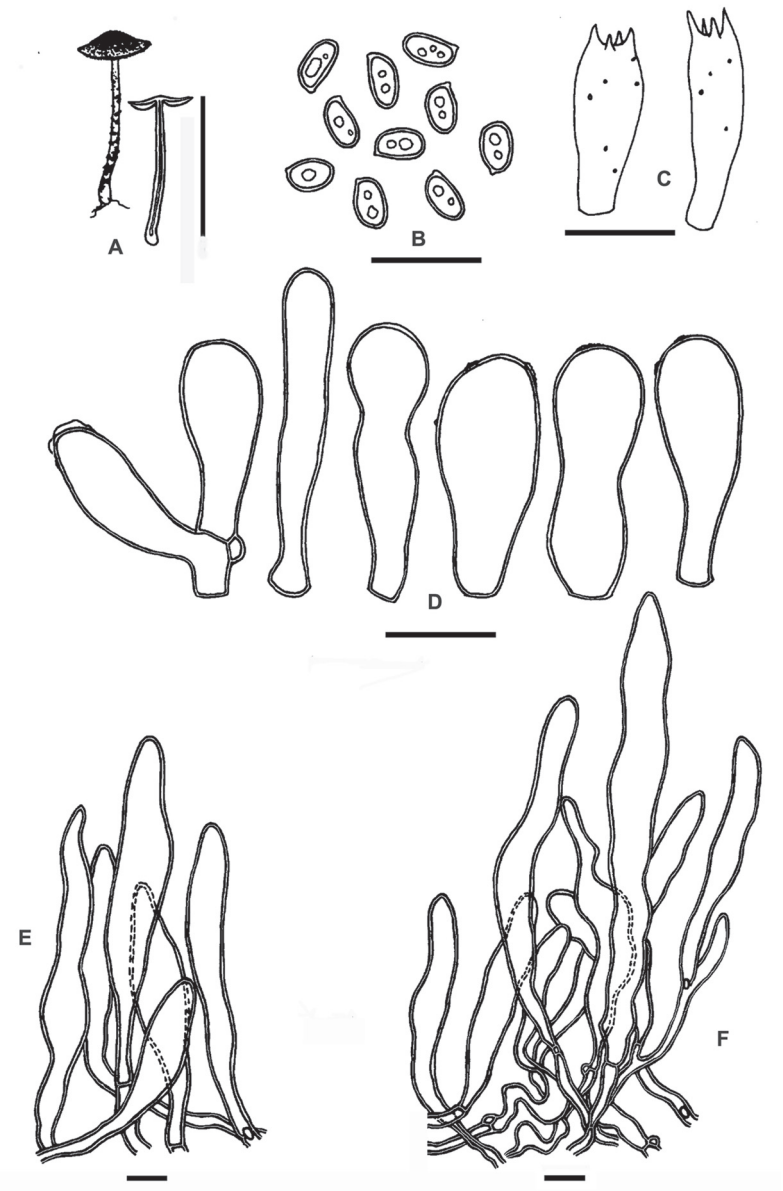


Figure 4. *Lepiota brevipes* var. *distincta*: A, habit, scale bar = 10 mm; B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering. Scale bars (B–F) = 10 μm.

Lamellar trama subregular; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, septate, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–20 µm wide, inflated, hyaline to pale yellowish, thin- to slightly thick-walled, inamyloid. Pileal covering a trichodermium with erect or ascending terminal elements, 24–120 × 4–12 µm, mostly fusoid, rarely cylindric, clavate, flexuose, or lageniform, thick-walled (up to 1.5 µm), with brown to dark brown plasmatic and membrane pigments. Stipe covering a highly disrupted cutis with trichodermial patches of ascending or erect, cylindric, flexuose, fusoid, lageniform or clavate terminal elements, 30–90 × 5–10 µm, thick-walled, with brown to dark brown plasmatic and wall pigment. All hyphae with clamp connections.

Habitat: On soil and decaying leaf litter, solitary or scattered.

Other collections examined — INDIA, Kerala State, Thiruvananthapuram District, PALODE: 18 July 2005, Arun Kumar AK354a (K(M)157115); 20 July 2005, Arun Kumar AK372; KALLAR, 4 August 2006, Arun Kumar AK434; Calicut District, PERUVANNAMUZHI, 25 September 2006, Arun Kumar AK441.

Discussion: This variety differs from the typical variety in showing a few minor variations such as an overall rose tint of the larger and more robust basidiomata, whitish pileal background, appendiculate pileal margin, white context and lamellae, and cheilocystidia with amorphous encrustations.

Lepiota xanthophylla P.D. Orton, Trans. Br. mycol. Soc. 43: 289 (1960)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 9 July 2005, Arun Kumar AK346 (K(M)157128); 12 July 2005, Arun Kumar AK349.

Discussion: *Lepiota xanthophylla* is a yellow species with ellipsoid spores. It is known in European countries only from green houses and not from natural habitats, thereby indicating its tropical origin as mentioned by Vellinga & Huijser (1998). The present collections agree with the description of this species given by Orton (1960), Vellinga & Huijser (1998) and Vellinga (2001b). It differs from the closely related *L. elaiophylla* mainly by the presence of numerous short clavate cells along with the long cylindrical elements in the pileus covering and by the cheilocystidia which are mostly narrowly lageniform to narrowly utriform. *L. elaiophylla* lacks these distinctive elements. This is the first record of *L. xanthophylla* from India.

Lepiota elaiophylla Vellinga & Huijser, Boll. Gruppo Micol. G. Bresadola 40(2–3): 462 (1998) ["1997"]

Collections examined — INDIA, Kerala State, Calicut District, KOYILANDY: 27 October 2004, Arun Kumar AK154 (K(M)157140); 3 November 2004, Arun Kumar AK154a (K(M)157141); 3 November 2004, Arun Kumar AK168; 20 November 2004, Arun Kumar AK154b; 13 October 2006, Arun Kumar AK456; Malappuram District,

CALICUT UNIVERSITY CAMPUS, 8 June 2005, Arun Kumar AK239; 9 June 2005, Arun Kumar AK239a; 21 June 2005, Arun Kumar AK281.

Discussion: This yellow *Lepiota* has characteristics that match with the original description of *L. elaiophylla*. Vellinga & Huijser (1998) distinguish this species from *L. xanthophylla* primarily by the lack of a layer of clavate short elements in-between the cylindric to fusiform terminal elements in the pileus. Until now *L. elaiophylla* has only been reported from green houses in Europe. This report is the first record of this species from a tropical region.

Lepiota ianthinosquamosa Pegler, Kew Bull., Addit. Ser. 9: 389 (1983)

Collections examined — INDIA, Kerala State, Calicut District, PERUVANNAMUZHY: 13 November 2004, Arun Kumar AK195 (K(M)157142); 22 July 2004, Arun Kumar AK195a.

Discussion: The macro- and micromorphologic characteristics of our present collection agree well with Pegler's (1983) description of this species from the Lesser Antilles, except for the slightly smaller spores and larger pileal elements. The lacrymoid to subcylindric spores and the trichodermial pileal covering place this species in the section *Ovisporae*. Macroscopically this species is somewhat similar to *L. fuscovinacea* F.H. Møller & J.E. Lange, but *L. ianthinosquamosa* clearly differs in having darker coloured fruit bodies, larger and distinctly lacrymoid spores, and clamp connections. *Lepiota ianthinosquamosa* has so far been reported only from the Lesser Antilles, this report is the first record of it occuring in the paleotropics.

Lepiota viriditincta (Berk. & Broome) Sacc., Syll. Fung. 5: 59 (1887)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 9 November 2004, Arun Kumar AK177 (K(M)157145); 9 November 2004, Arun Kumar AK180; 10 November 2004, Arun Kumar AK177a; 27 June 2005, Arun Kumar AK319.

Discussion: *Lepiota viriditincta* is a small species that exhibits a greyish green discolouration on bruising on all parts of the basidioma. It has a white pileus covered with minute brown squamules and finely striate towards the margin, an evanescent annulus, amygdaliform spores, and a pileal covering disrupted by trichodermial patches of cylindric to clavate terminal elements with brown plasmatic and encrusting pigments.

Characteristics of the present collections agree well with those of the species provided by Manimohan et al. (1988) from Kerala and by Pegler (1972, 1986) from Sri Lanka (based on the holotype at Kew) except for the somewhat smaller basidiomata and slightly larger spores. The lamella-edge was not recovered from the Sri Lankan material that Pegler studied and hence details on the cheilocystidia are lacking in his description. Manimohan et al. (1988) noted

the absence of cystidia in their collections from Kerala. The present collections from Kerala too, did not show cheilocystidia in any of the specimens.

Lepiota anupama T.K.A. Kumar & Manim., **sp. nov.** Figure 5

MycoBank MB511880

Pileus 15–20 mm latus, convexus vel companulatus, applanato expansus, umbonatus, albidus, squamulis griseobrunneis furfuraceis ad discum confortioribus obtectus, ad margineum striatus. Lamellae liberae, albae, confertae. Stipes 23–40 × 2–3 mm, ad basim leniter incrassatus, albidus. Sporae 5–7 × 3.5 µm, late ellipsoideae, hyalinae, dextrinoideae. Basidia 14–20 × 7–10 µm, clavata, 4- sporigera. Acies lamellarum sterilis. Cheilocystidia 20–59 × 6–15 µm, cylindrico-clavata, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composite. Hyphae raro fibulatae.

Holotype: INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 26 June 2006, Arun Kumar AK400 (K(M)155993, holotype).

Etymology: *anupama* (Sanskrit), without comparison

Basidiomata small. Pileus 15–20 mm diam., initially convex, becoming campanulate to broadly convex, applanate on maturity, obtusely umbonate at the disc; surface whitish with brownish grey (8F2, 11E2, 11F2) to reddish grey (12F2) flaky squamules concentrated more towards the disc, finely sulcate-striate towards margin; margin incurved, becoming straight, entire, becoming fissile with age. Lamellae free, white, crowded, up to 2.5 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 23–40 × 2–3 mm (up to 5 mm at base), central, terete, almost equal above the annulus, expanding towards the base, solid when young, becoming hollow; surface whitish, almost glabrous to slightly fibrillose; base arising from a white mycelium. Annulus superior, membranous, ascending, fixed, whitish. Context less than 1 mm thick, white. Odour not distinctive. Spore-print white.

Spores 5–7 × 3.5–5 (5.7 ± 0.4 × 4 ± 0.2) µm, Q = 1.25–1.5, Qm = 1.44, oblong-ellipsoid to broadly ellipsoid, hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. Basidia 14–20 × 7–10 µm, clavate, rarely broadly clavate, with guttulate contents, bearing 4 sterigmata up to 3 µm long. Lamella-edge sterile. Cheilocystidia 20–59 × 6–15 µm, cylindrico-clavate to cylindric-flexuose, rarely with a subcapitate apex, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 3–31 µm wide, inflated, septate, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–22 µm wide, hyaline, thin-walled, septate, inamyloid. Pileal covering a cutis of filamentous repent hyphae disrupted by trichodermial patches of agglutinated hyphal bundles with cylindrical, clavate or ellipsoid, 12–65 × 5–12 µm large, thin- to slightly thick-

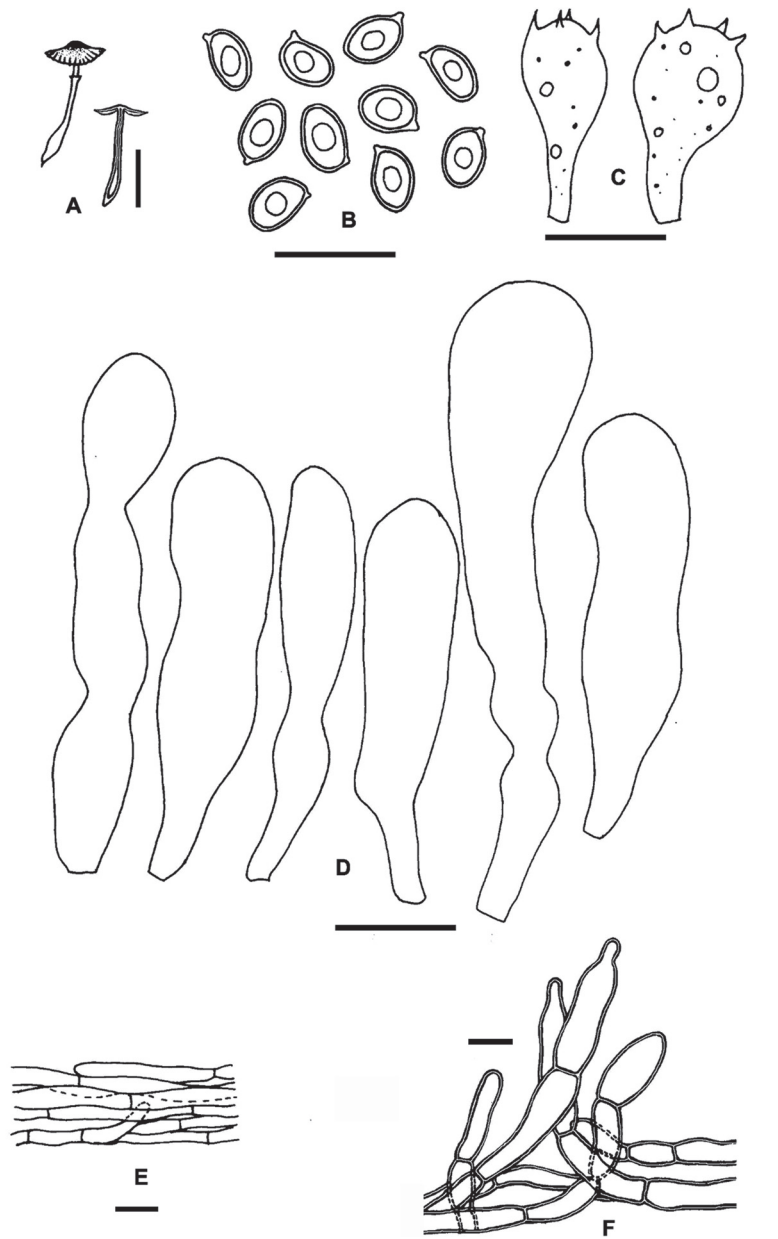


Figure 5. *Lepiota anupama*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

walled terminal elements with obtuse or acuminate tips and dense brownish grey to dark grey plasmatic pigment. Stipe covering a cutis of 3–15 µm wide, hyaline, thin-walled hyphae with cylindrical, 22–43 × 5–8 µm large terminal elements. Clamp connections rare, observed only from hyphae of the pileal covering.

Habitat: On humus rich soil, solitary or scattered.

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 24 May 2004, Arun Kumar AK33; 26 May 2004, Arun Kumar AK33a; 26 May 2004, Arun Kumar AK38; 6 June 2005, Arun Kumar AK234; 20 November 2006, Arun Kumar AK460; Calicut District, PUTHIYANGADI, 12 November 2003, Arun Kumar AK13 (K(M)157116); 14 November 2003, Arun Kumar AK13a; 17 August 2004, Arun Kumar AK91 (K(M)157117); KOLAMALA, 19 July 2006, Arun Kumar AK420.

Discussion: A white pileal surface with scattered flaky squamules and finely striate margin, a fixed membranous annulus, oblong-ellipsoid to broadly ellipsoid spores, and a pileal covering that is basically a cutis but disrupted by trichodermial patches with cylindrical, clavate or ellipsoidal terminal elements are the major distinguishing features of this species, and do not exactly match with those of any of the known taxa. It is somewhat similar to *Lepiota columbicolor* (Berk. & Broome) Sacc. as described by Pegler (1972, 1986). However, *L. columbicolor* differs from the Kerala material because of the following characteristics of the former: 1) greyish pileal and stipe surface; 2) pink lamellae with brownish edge; 3) grey context; 4) narrower spores with slight apical attenuation; 5) cheilocystidia with greyish plasmatic pigment; and 6) an entirely cutis-type pileal covering. Macro-morphologically, *L. lilacea* Bres. from Venezuela (Dennis 1961) somewhat resembles the present species but has a vinaceous-cinnamon stipe, an annulus that is dark purplish grey beneath, and squamules composed of a hymeniform layer of clavate terminal cells.

Lepiota anupama is very common in the Calicut and Malappuram Districts of Kerala and it has been observed to fruit immediately on the onset of monsoon. Fruiting continues for about one-and-a-half weeks and gradually stops with increasing rainfall.

Lepiota ananya T.K.A. Kumar & Manim., **sp. nov.** Figure 6

MycoBank MB511876

Pileus 14–25 mm latus, primo convexus, postea applanatus, umbonatus, albidus, squamulis appressis atro-brunneis ad discum confertioribus obtectus, ad marginem subtiliter striatus. Lamellae liberae, pallide luteae, confertae. Stipes 22–40 × 1.5–5 mm, ad basim incrassatus, albidus, fibrillosus. Sporae 5.5–8 × 3.5–4.5 µm, amygdaliformiae, hyalinae, dextrinoideae. Basidia 13–21 × 8–10 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 15–37 × 7.5–10 µm, versiformia, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae raro fibulatae.

Holotype — INDIA, Kerala State, Thiruvananthapuram District, PALODE: 15 July 2005, Arun Kumar AK351 (K(M)155996, holotype).

Etymology: *ananya* (Sanskrit), unique

Basidiomata small. Pileus 14–25 mm diam., initially convex, becoming broadly convex and finally applanate, distinctly umbonate at the disc; surface whitish, sometimes with a yellowish tinge, with dark brown (8F8) appressed fibrillose squamules more concentrated towards the centre, almost smooth at the disc, finely striate towards the margin; margin initially incurved, later straight, crenate. Lamellae free, pale yellow (2A2) to light yellow (3A5), crowded, up to 3 mm wide, with lamellulae in 3–4 tiers; edge fimbriate under a lens, concolorous with the sides. Stipe 22–40 × 1.5–5 mm, central, terete, expanding towards base, initially fistulose, becoming hollow; surface whitish, fibrillose; base arising from a white mycelium. Annulus superior, membranous, ascending, whitish. Context up to 2 mm thick, whitish to pale yellow (2A2). Odour not distinctive. Spore-print not obtained.

Spores 5.5–8 × 3.5–4.5 (5.7 ± 0.9 × 4 ± 0.22) µm, Q = 1.3–2, Qm = 1.6, amygdaliform, thick-walled (up to 1 µm), hyaline, with refractive guttules, smooth, dextrinoid, non-metachromatic, cyanophilic. Basidia 13–21 × 8–10 µm, clavate, some broadly clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 5 µm long. Lamella-edge sterile. Cheilocystidia crowded, 15–37 × 7.5–10 µm, cylindrical, clavate, or utriform, some septate, rarely constricted, thin-walled, hyaline or pale yellowish. Pleurocystidia none. Lamellar trama subregular; hyphae 2–17 µm wide, thin-walled, hyaline to pale yellow, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–17 µm wide, cylindrical, thin-walled, hyaline to pale yellowish, inamyloid. Pileal covering a cutis of interwoven filamentous hyphae, with occasional ascending or erect terminal elements; hyphae 3–14 µm wide, thin- to slightly thick-walled and with brown to dark grey plasmatic, membrane and encrusting pigments. Stipe covering a cutis of repent, cylindrical, 2–10 µm wide, thin-walled, hyaline hyphae. Clamp connections rare.

Habitat: On decaying leaf litter, solitary or scattered.

Discussion: Yellowish lamellae, amygdaliform spores, a cutis-type pileal covering composed of cylindrical hyphae with brown to dark grey plasmatic, membrane- and encrusting pigments, and rare clamp connections make this species unique. *Lepiota epicharis* (Berk. & Broome) Sacc. seems to be very close to the present species except for the pileal covering, which is a disrupted epithelium of inflated clavate or pyriform elements (Pegler 1986) in that species.

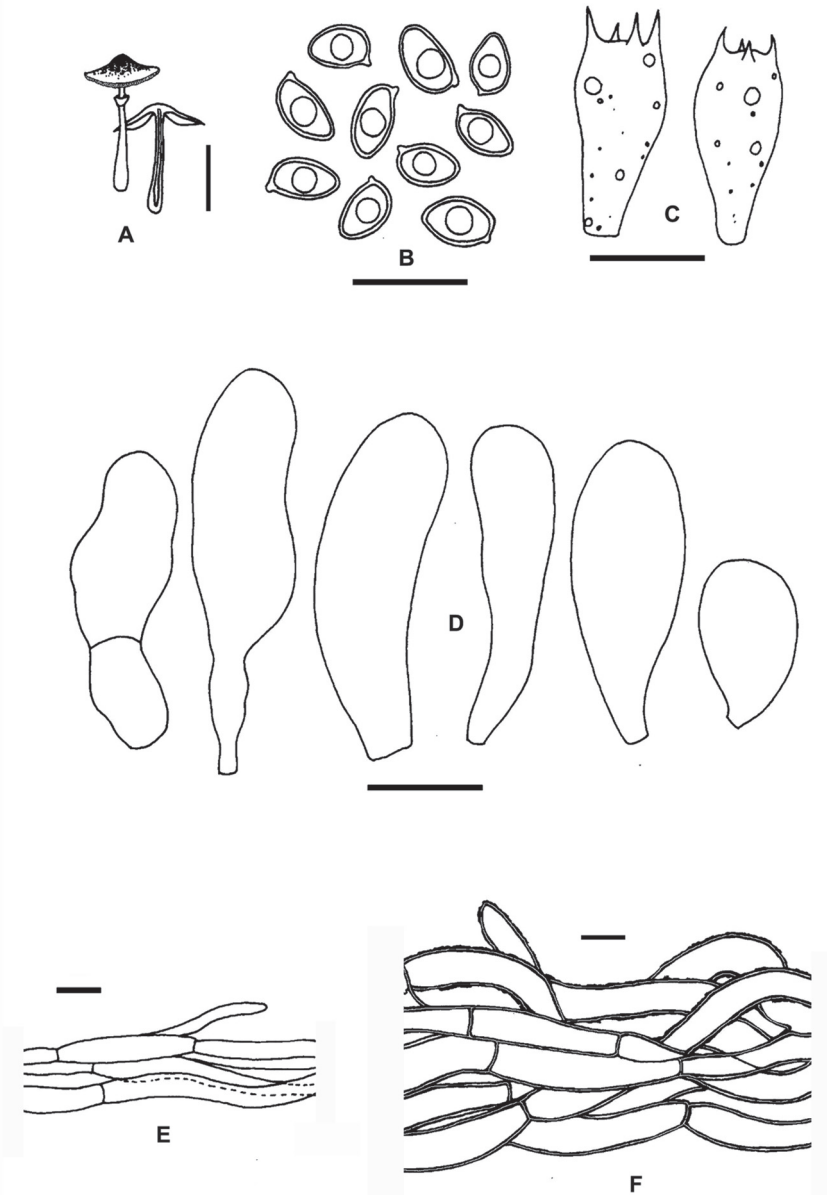


Figure 6. *Lepiota ananya*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

Lepiota babruzalka T.K.A. Kumar & Manim., **sp. nov.** FIGURE 7

MycoBank MB511881

Pileus 10–13 mm latus, primo subglobosus, postea convexus vel applanatus, umbonatus, albidus, squamulis minutis appressis rubro-brunneis ad discum confertioribus obtectus, ad marginem non-striatus. Lamellae primo albidae, postea pallide luteae, confertae. Stipes 26–45 × 1–1.5 mm, ad basim bulbosus, albidus, obscure fibrillosus. Sporae 5.5–10.5 × 3.5–4.5 µm, oblongo-ellipsoideae vel subcylindricae, hyalinae, dextrinoideae. Basidia 15–20 × 7–8 µm, clavata, 1- ad 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 13–32 × 7–12 µm, cylindrico-clavata vel clavata, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae perraro fibulatae.

HOLOTYPE — INDIA, Kerala State, Calicut District, CHELAVUR: 12 November 2004, Arun Kumar AK191 (K(M)155995, HOLOTYPE).

ETYMOLOGY: *babruzalka* (Sanskrit), brown-scaled

BASIDIOMATA small. PILEUS 10–13 mm diam., subglobose when young, becoming broadly convex to applanate, obtusely umbonate at the disc; surface dull white with scattered, minute, appressed, reddish brown (8E5, 8E6) squamules that are concentrated at the disc, non-striate; margin initially incurved, becoming straight, appendiculate. LAMELLAE free, white, turning orange-white (5A2) on maturity, crowded, up to 2 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 26–45 × 1–1.5 mm, central, terete, almost equal with a bulbous base, initially solid, becoming fistulose; surface dull white, becoming light brown (7D7) on bruising, faintly fibrillose. ANNULUS superior, membranous, ascending, movable, evanescent, whitish. CONTEXT less than 1 mm thick, whitish to dull white. ODOUR not distinctive. SPORE-PRINT white.

SPORES 5.5–10.5 × 3.5–4.5 (7.5 ± 0.97 × 4 ± 0.23) µm, Q = 1.4–2.4, Qm = 1.9, oblong-ellipsoid, subcylindric, or rarely subamygdaliform, hyaline, with a refractive guttule, thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 15–20 × 7–8 µm, clavate, with guttulate contents, hyaline, 1–4-spored; sterigmata up to 8 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA abundant, 13–32 × 7–12 µm, mostly cylindrico-clavate to clavate, rarely broadly clavate, utriform or ventricose-rostrate, occassionally septate, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 3–15 µm wide, inflated, septate, thin-walled, hyaline to pale yellow, inamyloid. SUBHYMENIUM cellular, prominent, up to 10 µm wide. PILEAL TRAMA interwoven; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, inamyloid. PILEAL COVERING a differentiated, disrupted cutis becoming more or less trichodermial towards the disc; terminal elements 13–31 × 4–7 µm, cylindrical or clavate, thin- to slightly thick-walled, with obtuse or acuminate apices and with brownish grey to dark grey plasmatic, membrane and encrusting pigments; elements towards the margin sparsely pigmented. STIPE COVERING a

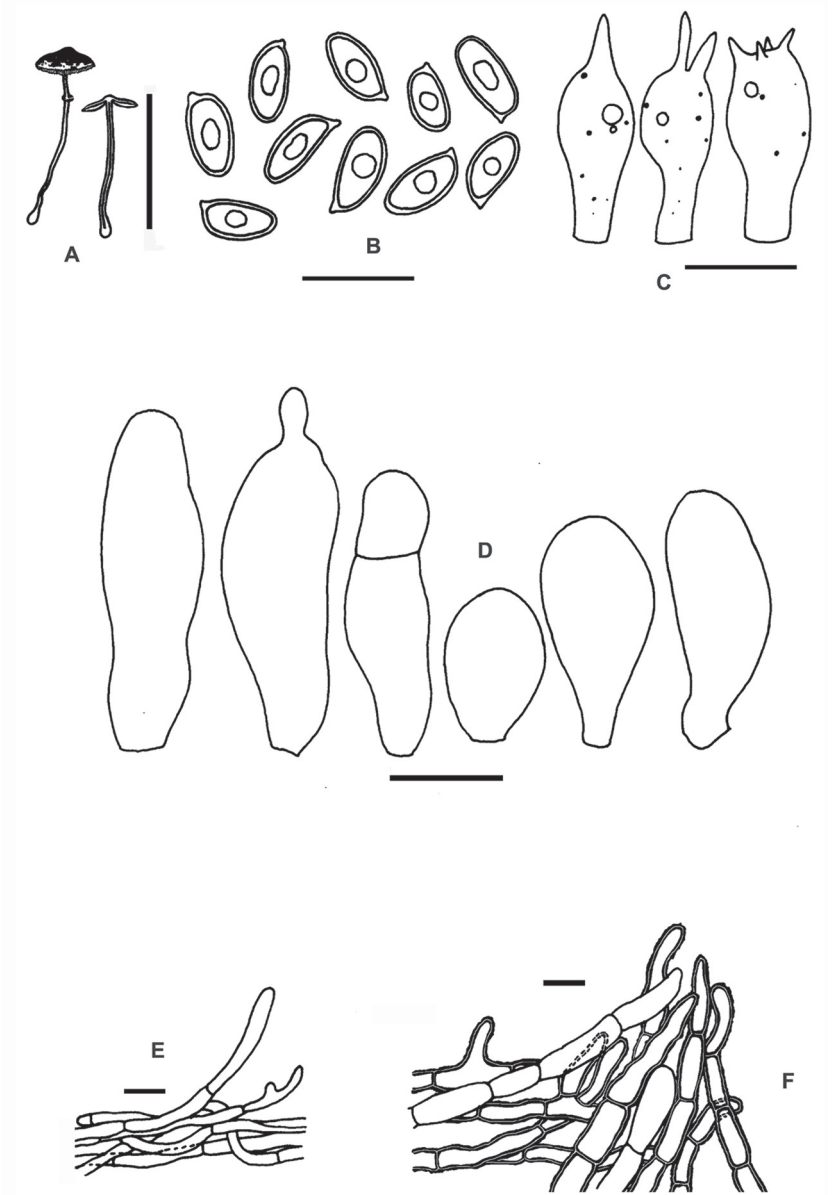


Figure 7. *Lepiota babruzalka*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

disrupted cutis with occassional ascending or erect, cylindrico-clavate terminal elements, 14–40 × 6–8 µm, thin-walled, hyaline or with pale grey plasmatic pigment. Clamp connections very rare.

Habitat: On soil among decaying leaf litter around the base of bamboo stands, solitary or scattered.

Other collections examined — INDIA, Kerala State, Calicut District, CHELAVUR: 21 November 2004, Arun Kumar AK191a (K(M)157129); 8 October 2006, Arun Kumar AK191b (K(M)157130); Malappuram District, NILAMBUR, 11 October 2006, Arun Kumar AK455.

Discussion: A long, slender, but more or less firm, stipe, one- to four-spored basidia, versiform cheilocystidia, and a trichodermial pileal disc composed of cylindrical or clavate terminal elements with plasmatic, membrane, and encrusting pigments are the distinguishing features of this species.

Lepiota roseoalba Henn., seems to be the only previously described species that is somewhat similar to the Indian specimens. A comparison with *L. roseoalba* as described by Pegler (1977) reveals that *L. babruzalka* is distinguished based on its reddish brown pileal squamules, non-striate pileus margin, slender stipe and differently pigmented cylindrical terminal elements of the pileal covering.

Lepiota shveta T.K.A. Kumar & Manim., **sp. nov.** Figure 8

MycoBank MB511882

Pileus 5–24 mm latus, ovoideus vel conico-companulatus, applanato expansus, albus, squamulis furfuraceis ad discum confertioribus obtectus, ad marginem estriatus. Lamellae liberae, albae, confertae. Stipes 15–32 × 1.5–4 mm, albidus, squamulis adpressis obtectus. Sporae 6–9.5 × 3.5–5 µm, oblongae vel subcylindricae, hyalinae, dextrinoideae. Basidia 17–24 × 6.5–8.5 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 14–32 × 7–13 µm, clavata vel cylindrico-clavata, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes fibulatae.

Holotype — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 9 November 2004, Arun Kumar AK176 (K(M)155994, holotype).

Etymology: *shveta* (Sanskrit), white

Basidiomata small. Pileus 5–24 mm diam., ovoid when very young, becoming conico-convex and finally applanate, indistinctly umbonate; surface white, furfuraceous, appressed-fibrillose or almost pruinose in some specimens especially towards the centre; non-striate; margin initially incurved, becoming straight on maturity, appendiculate, splitting up to the middle with age. Lamellae free, white, close to crowded, up to 3 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 15–32 × 1.5–4 mm, central, terete, equal or rarely slightly expanded towards the base, fistulose to hollow; surface white, turning pale brownish orange (6C7) on

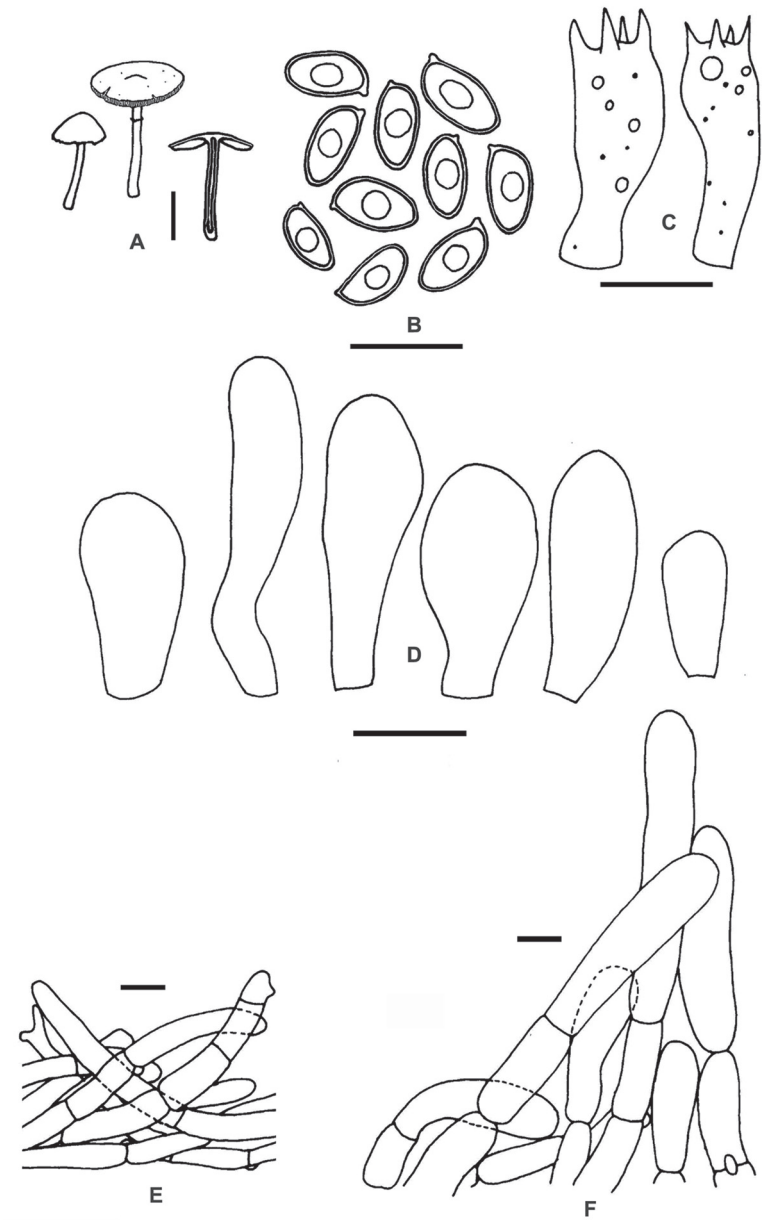


Figure 8. *Lepiota shveta*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

bruising, fibrillose, with minute appressed squamules; base arising from white mycelial cords. Annulus superior, fibrillose, evanescent, white. Context up to 1 mm thick, white. Odour not distinctive. Spore-print white.

Spores 6–9.5 × 3.5–5 (8 ± 0.83 × 4.25 ± 0.47) µm, Q = 1.7–2.25, Qm = 1.9, oblong to subcylindrical, rarely amygdaliform, hyaline, with guttulate contents, slightly thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. Basidia 17–24 × 6.5–8.5 µm, clavate, often with guttulate contents, bearing 4 sterigmata up to 4.5 µm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–32 × 7–13 µm, clavate to cylindrico-clavate, hyaline, thin-walled. Pleurocystidia none. Lamellar trama subregular; hyphae inflated, septate, 2–25 µm wide, hyaline, thin-walled, inamyloid. Subhymenium up to 20 µm wide, cellular. Pileal trama somewhat interwoven; hyphae of 2–28 µm wide, highly inflated, septate, hyaline, thin-walled, inamyloid, branched. Pileal covering a disrupted cutis of 3–14 µm wide, thin-walled, hyaline to pale brown or pale grey filamentous hyphae with trichodermial patches of erect or ascending hyphal bundles with clavate, cylindrical or cylindrico-clavate end cells, 15–65 × 4–15 µm, with obtusely rounded apices and pale grey plasmatic pigments. Stipe covering a highly disrupted cutis with ascending agglutinated or loose hyphal elements with cylindrical, unpigmented end cells, at times branched towards the apex. Clamp connections rare.

Habitat: On soil and decaying leaf litter, solitary or scattered.

> Other collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 4 October 2004, Arun Kumar AK117 (K(M)157118); 5 October 2004, Arun Kumar AK117a (K(M)157119); 9 November 2004, Arun Kumar AK117b; 10 November 2004, Arun Kumar AK183; 16 November 2004, Arun Kumar AK201.

Discussion: This species is characterized by: 1) white basidiomata; 2) change of colour of stipe to pale brownish orange on bruising; 3) large, mostly oblong to subcylindrical spores; 4.) cylindrico-clavate to clavate cheilocystidia 5) cylindrical to clavate pileal elements; and 6) clamp connections. This combination of characters makes it distinct from all other previously described taxa. *Lepiota amplifolia* Murrill is a species that comes close because of the macromorphological affinities, but it has 'isabelline-testaceous' scales on the pileus, 'triangular' lamellae, 7–9 cm long stipe that becomes rose-tinted on drying, and large spores that are 8–9 × 3.5 µm (Murrill 1912). *Leucoagaricus serenus* (Fr.) Bon & Boiffard is a species that show a high degree of macroscopic similarity but microscopically it is very different (Vellinga 2001c). This species is very common in the Malappuram District of Kerala, especially in the Calicut University Campus and adjoining areas.

Lepiota harithaka T.K.A. Kumar & Manim., **sp. nov.** FIGURE 9

MycoBank MB511883

Basidiomata contusae griseo-virido decolorans. Pileus 20–35 mm latus, convexus, applanato expansus, postremo depressus, albidus, squamulis granularis brunneis ad discum confertioribus obtectus, non-striatus. Lamellae liberae, pallide luteae, confertae. Stipes 43–72 × 2–4 mm, equalis vel basim leniter incrassatus, albidus. Sporae 5–7 × 3–4 µm, ellipsoideae vel amygdaliformiae, hyalinae, crassitunicatae, dextrinoideae. Basidia 14–20 × 5–7 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 20–39 × 7–21 µm, clavata, raro utriformia, cristata. Pleurocystidia nulla. Trama hymenophoralis subregularis. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Fibula non visa.

HOLOTYPE — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 6 June 2006, Arun Kumar AK388 (K(M)155997, HOLOTYPE).

ETYMOLOGY: *harithaka* (Sanskrit), greenish

BASIDIOMATA small, all parts turning greyish green (27E5) on bruising. PILEUS 20–35 mm diam., convex when young, becoming broadly convex, then applanate and finally depressed with maturity, with an indistinct umbo; surface dull white, with scattered brown (6E5-7E5) fibrillose squamules giving a granular appearance, non-striate; squamules concentrated towards the centre, appearing almost pruinose at the disc, sparse towards the margin, margin initially incurved, later straight, entire. LAMELLAE free, crowded, up to 5 mm wide, pale yellow (1A3, 2A3), with lamellulae in 8–9 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 43–72 × 2–4 mm (up to 6 mm at the base), central, terete, almost equal or expanded towards the base, slightly bulbous at the base, fistulose; surface whitish to dull white, smooth, fibrillose; base arising from a white mycelium. ANNULUS superior, membranous, evanescent, whitish. CONTEXT up to 5 mm thick at the disc, whitish. ODOUR not distinctive. SPORE-PRINT yellowish white (1A2).

SPORES 5–7 × 3–4 (6 ± 0.54 × 3.8 ± 0.44) µm, Q = 1.4–2, Qm = 1.6, ellipsoid to amygdaliform, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 14–20 × 5–7 µm, cylindrico-clavate, clavate, hyaline to pale green, bearing 4 sterigmata up to 5 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 20–39 × 7–21 µm, mostly clavate, rarely utriform, thin- to slightly thick-walled (up to 0.5 µm), speckled with crystalline encrustations, with hyaline to greenish contents. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 3–17 µm wide, hyaline to pale green, thin- to slightly thick-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 4–20 µm wide, hyaline to pale grey, thin- to slightly thick-walled, inamyloid. PILEAL COVERING a highly disrupted cutis towards the margin, of septate, 4–15 µm wide, thin- to slightly thick-walled hyphae with pale grey to grey plasmatic and membrane pigments,

bluish green to blue pigmented at bruised parts; entirely trichodermial at the disc; terminal elements 27–65 × 10–20 µm, ellipsoid, cylindric or clavate, with obtuse apex, thin to slightly thick-walled, with pale grey to dark grey plasmatic, membrane and encrusting pigments. Stipe covering a cutis rarely disrupted by ascending hyphal elements; hyphae 4–16 µm wide, thin- to slightly thick-walled, hyaline to pale grey. Clamp connections absent.

Habitat: On soil among dead and living bamboo roots, solitary, scattered.

Other collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 15 June 2006, Arun Kumar AK396 (K(M)157132), 3 July 2006, Arun Kumar AK407 (K(M)157133); 26 September 2006, Arun Kumar AK443; 27 September 2006, Arun Kumar AK448.

Discussion: *Lepiota harithaka* is an interesting species with basidiomata that turn greyish green on bruising. It is additionally characterized by pale yellow lamellae, ellipsoid to amygdaliform spores that are non-metachromatic in cresyl blue, cheilocystidia that are clavate and slightly thick-walled with greenish plasmatic contents and crystalline surface encrustations, elements of the pileal covering with plasmatic, membrane- and encrusting pigments, and absence of clamp connections. This combination of characteristics does not match any species description so far published.

This species is kept here under the genus *Lepiota*, as the spores clearly failed to give a metachromatic reaction with cresyl blue, although the lack of clamp connections would suggest *Leucoagaricus*. Observations during this study show that presence or absence of clamp connections is not a reliable character to draw generic demarcations, as many collections from Kerala otherwise accepted under *Leucoagaricus* had clamp connections and *Lepiota* species that lack clamps are also found accepted (e.g. the section *Anomalae* Locq.; the section *Fuscovinaceae* Bon & Candusso) in the literature. Following Singer's (1986) infrageneric classification, the present species may be placed inside the section *Anomalae*, a section established as a repository for all the anomalous species lacking clamp connections. Vellinga (2003) found this section to be a very artificial group with species belonging to the other sections of *Lepiota* and *Leucoagaricus* as well. If the absence of clamp connections is taken as an exception, owing to the ellipsoid to amygdaliform spore shape and the trichodermial nature of the pileal covering, this species could be placed in the section *Ovisporae*.

There are a few *Lepiota* species with a whitish context, that show a greenish colour change on handling or when bruised. *Lepiota viriditincta*, discussed earlier, is one such species belonging to the section *Ovisporae* that has been reported from Sri Lanka (Pegler 1972, 1986) and Kerala, India (Manimohan et al. 1988). But that species has smaller basidiomata, less dense pileal squamules, larger spores, smaller cheilocystidia, and possesses clamp connections.

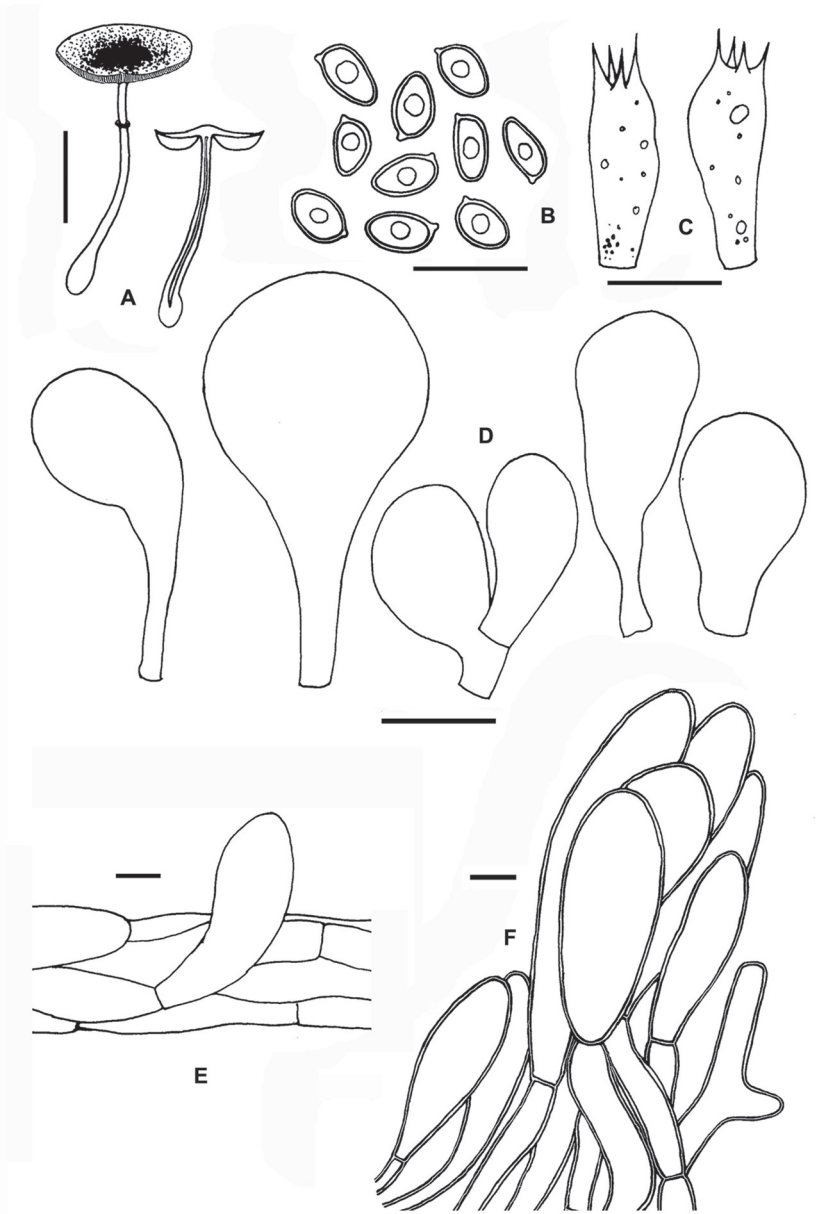


Figure 9. *Lepiota harithaka*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

Lepiota cyanescens Beeli differs in being larger-sized and with much larger spores. *Lepiota caerulescens* Peck, another white fleshed species, is known to show a combination of blue, green and reddish tints upon handling (Akers et al. 2000). The other species that turn green or bluish green on bruising, like *Lepiota viridiflava* Petch, *Leucoagaricus viridiflavoides* B.P. Akers & Angels and *Leucocoprinus sulphurellus* Pegler, have a noticeably yellow context apart from other differences (Akers et al. 2000).

Lepiota plumbicolor (Berk. & Broome) Sacc., Syll. Fung. 5: 63 (1887)

Collections examined — INDIA, Kerala State, Wayanad District, KOTTATHARA: 1 October 2004, Arun Kumar AK109 (K(M)157139); Calicut District, MANANCHIRA, 2 October 2004, Arun Kumar AK114; 5 October 2004, Arun Kumar AK114a.

Discussion: This species is characterized by: 1) a pileus covered with brownish grey or blackish, appressed squamules; 2) ellipsoid to oblong-ellipsoid spores more than 5 µm long and less than 5 µm broad; 3) pileal and stipe covering with trichodermial patches comprised of cylindrical terminal elements with brownish grey plasmatic pigment; and 4) the total absence of clamp connections. This species was placed by Pegler (1972, 1986) under the section *Anomalae* mainly because of the absence of clamp connections. The collections from Kerala have characteristics agreeing with the account of the species given by Pegler (1972, 1986), based on the type material (Thwaites 864 cum icon, December 1868, deposited at K) originally described by Berkeley & Broome from Sri Lanka. The Kerala collections, however, have whitish lamellae, fugacious annulus, and much wider cheilocystidia. This forms the first record of this species from India.

Lepiota murinocapitata Dennis, Kew Bull. 15: 114 (1961)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 26 October 2004, Arun Kumar AK152 (K(M)157143).

Discussion: This species is distinguished by its dark grey pileus with appressed squamules, white lamellae turning pale yellow, subamygdaliform spores that are non-metachromatic in cresyl blue, fixed annulus, and cuticular pileal covering with loosely arranged hyphae terminated by darkly pigmented cylindrical elements. Clamp connections are absent in this species. Most of the features of the Kerala collections point towards *Lepiota murinocapitata* originally described from Venezuela by Dennis (1961, 1970). However, in the Kerala collection the lamellae were observed to be initially white that gradually became pale yellow, the stipe showed a dull white to grey colour that turned brown on bruising, and the fibrillose annulus was persistent and without a grey-coloured edge. Despite these differences, we tentatively label the Kerala material, represented by only a single collection, as *Lepiota murinocapitata*.

Acknowledgments

We express our gratitude to Prof. T. J. Baroni and Prof. L. Guzmán-Dávalos for reviewing our manuscript and providing suggestions. Thanks are also due to Dr. S. R. Pennycook for nomenclatural review and Dr L. L. Norvell for editorial review.

Literature cited

Akers BP, Sundberg WJ. 1998. *Lepiotaceae* of Florida, I. *Lepiota* s. str., section *Ovisporae*. Mycotaxon 69: 429–436.

Akers BP, Angels SA, Kimbrough JW. 2000. *Leucoagaricus viridiflavoides*, a new species from Florida, with notes on related taxa. Mycotaxon 76: 39–50.

Bon M. 1996. Die Grosspilzflora von Europa. *Lepiotaceae*. IHW-Verlag, Germany.

Britenbach J, Kränzlin F. 1995. Fungi of Switzerland. Vol. 4. Agarics 2nd Part. Mykologia, Luzern.

Candusso M, Lanzoni G. 1990. *Lepiota s.l.* Fungi Europaei 4. Giovanna Biella, Saronno.

Dennis RWG. 1952. *Lepiota* and allied genera in Trinidad, British West Indies. Kew Bulletin 7: 459–499.

Dennis RWG. 1961. Fungi venezuelani: IV. *Agaricales*. Kew Bulletin 15: 67–156.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bulletin Additional Series 3: 54–57.

Guzmán G, Guzmán-Dávalos L. 1992. A checklist of lepiotaceous fungi. Koeltz Scientific Books, Champaign, Illinois.

Huijsman HSC. 1962. Sur le probléme *Lepiota helveola* Bres. Persoonia 2: 355–370.

Knudsen H. 1978. Notes on *Cystolepiota* Sing. and *Lepiota* S.F. Gray. Botanisk Tidsskrift 73: 124–136.

Knudsen H. 1980. A revision of *Lepiota* sect. *Echinatae* and *Amyloideae* (*Agaricaceae*) in Europe. Botanisk Tidsskrift 75: 121–155.

Kornerup A, Wanscher JH. 1978. Methuen handbook of colour, 3rd edn. Methuen, London.

Manimohan P, Vrinda KB, Leelavathy KM. 1988. Rare agarics from Southern India. Kavaka 16: 50–56.

Manjula B. 1983. A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. Proceedings of the Indian Academy of Sciences (Plant Sciences) 92: 81–213.

Migliozzi V. 1997. Il complesso *Lepiota helveola* negli erbari trentini di G. Bresadola. Bolletino Del Gruppo Micologico G. Bresadola 40: 327–336.

Murrill WA. 1912. The *Agaricaceae* of the Pacific coast-II. Mycologia 5: 231–262.

Natarajan K, Manjula B. 1983. South Indian *Agaricales* XII. *Lepiota*. Bibliotheca Mycologica 91: 563–581.

Natarajan K, Kumaresan V, Narayanan K. 2005. A checklist of Indian agarics and boletes. Kavaka 33: 61–128.

Orton PD. 1960. New check list of British Agarics and Boleti. III. Notes on the genera and species in the list. Transactions of the British Mycological Society 43: 159–439.

Pegler DN. 1972. A revision of the genus *Lepiota* from Ceylon. Kew Bulletin 27: 155–202.

Pegler DN. 1977. A preliminary agaric flora of East Africa. Kew Bulletin Additional Series 6: 1–615.

Pegler DN. 1983. Agaric flora of the Lesser Antilles. Kew Bulletin Additional Series 9: 1–668.

Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bulletin Additional Series 12: 1–519.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4th edn. Koeltz Scientific Books, Koenigstein.

Smith HV. 1965. Contributions toward a monograph on the genus *Lepiota*, I. Type studies in the genus *Lepiota*. Contributions from the University of Michigan Herbarium 28: 97–117.

Vellinga EC. 2001a. *Cystolepiota*. In Noordeloos ME, Kuyper ThW, Vellinga EC (eds.). Flora Agaricina Neerlandica 5: 154–160. A.A. Balkema Publishers, Lisse.

Vellinga EC. 2001b. *Lepiota*. In Noordeloos ME, Kuyper ThW, Vellinga EC, (eds.). Flora Agaricina Neerlandica 5: 21, 109–151. A.A. Balkema Publishers, Lisse.

Vellinga EC. 2001c. *Leucoagaricus*. In Noordeloos ME, Kuyper ThW, Vellinga EC, (eds.). Flora Agaricina Neerlandica 5: 21, 85–108. A.A. Balkema Publishers, Lisse.

Vellinga EC. 2003. Phylogeny of *Lepiota* (*Agaricaceae*) – Evidence from nrITS and nrLSU sequences. Mycological Progress 2(4): 305–322.

Vellinga EC, Huijser HA. 1993. Notulae ad Floram Agaricinam Neerlandicam 21- *Lepiota* section. *Stenosporae*. Persoonia 15 (2): 223–240.

Vellinga EC, Huijser HA. 1998 ("1997"). *Lepiota xanthophylla* and its green house counterpart. Bolletino Del Gruppo Micologico G. Bresadola 40: 457–464.

Vrinda KB, Pradeep CK, Mathew S, Abraham TK. 1999. *Agaricales* from Western Ghats – VII. Mushroom Research 8: 9–12.

Vrinda KB., Pradeep CK, Abraham TK. 2001. Additions to Indian mushroom flora. Mushroom Research 10: 1–4.